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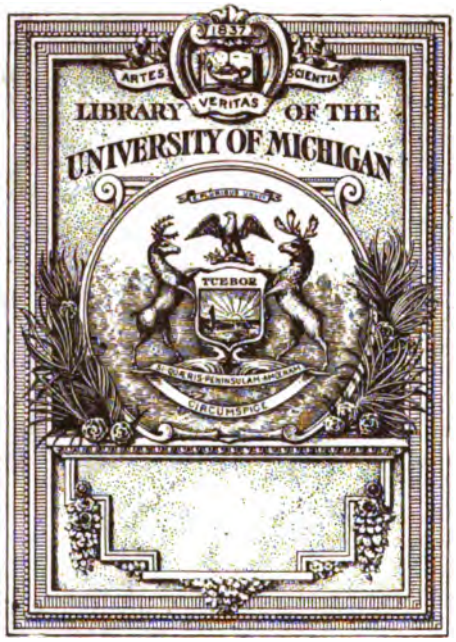

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ROADS AND HIGHWAYS:

COMMUNICATED TO

THE EDITOR

OF

THE EDINBURGH ENCYCLOPÆDIA,

BY

ROBERT STEVENSON,

CIVIL ENGINEER.

EDINBURGH:

PRINTED BY A. BALFOUR AND CO.

1824.

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ROADS AND HIGHWAYS.

Roads and Highways.

"NEXT to the genial influence of the seasons, upon which the regular supply of our wants, and a great portion of our comforts so much depend, there is perhaps no circumstance more interesting to men in a civilized state than the perfection of the means of interior communication." This sentiment, quoted in one of the reports of the committee of the House of Commons upon the highways of the kingdom, speaks to the heart and feelings of every one, and marks in a strong point of view, an object, which for the last twenty years, has more especially occupied the British legislature; so that while the field of battle has been oscillating between the extremes of Hamburgh and Rome, and of Madrid and Moscow, the domestic policy of Britain has in no instance been more striking than in opening the country by the formation of numerous roads. If we look comparatively to the map of Europe, the surface of the United Kingdom appears every where intersected with numerous roads, while in other countries they seem to radiate only from their respective capitals. Some years since, the writer of this article made a cursory estimate of the extent of the highways of Great Britain and Ireland, when it appeared, that, independently of an almost incalculable number of parish and private roads, the highways alone extended to about 25,000 miles. Upon a very moderate calculation of the expence of these roads, including bridges and compensation for land, we may state it at the rate of £800 per mile, which is equal to no less than the aggregate sum of twenty millions sterling. Now we may fairly ask, to what branch of political economy can we look for more splendid examples of internal resource? It has been truly said, that until a country is traversed and laid open by roads, its government must be weak, and its people remain in a state of poverty. On a subject of such universal interest as the formation of roads, the mind delights to dwell, while it traces their connexion with the progressive stages of civilization in the occupation of the hamlet, the village, and the city. Perhaps we shall best treat the historical part of our subject by a general reference to roads both at home and abroad.

Roads and Highways.

Roads of the ancients.

In speaking of the roads of other countries, we may observe that a people who have executed such splendid works as those of Egypt and Persia, must to a certain extent have had a system of roads corresponding to their habits, no less perfect than those of later times. The circle of the arts seems to move round, yet doubtless the same portion of mind has existed in every age, though our record or knowledge even of comparatively late periods, has by many perverted chances become extremely imperfect. The territory or jurisdiction of the Greeks and other nations who in early times flourished upon the shores of the Mediterranean was small; and although they achieved works of magnitude with a display of taste which still continues to be the subject of our wonder, and will perhaps ever remain to be consulted as our authorities, yet but little is known of their municipal affairs.

Of the Romans.

But it is far otherwise with the works of the Romans, whose conquests extended to all parts of the then known world. With that nation it was always a primary object to lay open subdued countries with roads to be applied to its future purposes either for obtaining supplies or securing a retreat. Such was the *Aurelian road*, which led from the gate of that name to Milan, and from thence across the Alps by various routes, forming the key to Gaul, and all the nations of the north. In Italy alone, the Romans are said to have laid about 14,000 miles of road. Of these the classic antiquary has been able to reckon many of the principal ways which led from Rome by the different gates, such as the *Appian, Salernian, Flaminian, Ostian, Praenestine, Tiburtine, Triumphal*, and others, varying in extent and importance according to the circumstances of the country through which they passed; and from these again, a vast number of subordinate roads, ramified in every direction. Some remains of these splendid works are still to be seen, though the face of the country in the lapse of ages, and the vicissitudes of time, has undergone such

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changes, as to leave little more to us than the mere recital of their names.

In the formation of roads, the Romans generally kept a straight line of direction, though at the expence of works of considerable difficulty; at one place performing extensive excavations, at another stretching over valleys by bridges and aqueducts, and boldly piercing the mountain, with under-ground tunnels, as that of Pozzuoli near Naples, cut about half a league through the solid rock, and forming a roadway or aperture of fifteen feet square. But in nothing is our wonder so much excited as at the pains bestowed in preparing a firm bottom for the structure of their roads. In some instances, they built walls of masonry, and strengthened the ground by ramming it with brick, rubbish, gravel, or small stones and flints, on which they laid a course of square blocks of various dimensions, not unfrequently cubes measuring eighteen inches upon their several sides, though the *lengthway* was generally the greatest. The surface of these roads was spacious, firm, and smooth. Many of them had a double row of pavement for carriages going in different directions. These were separated by a causeway in the middle, somewhat raised above the others, and paved with brick for the conveniency of foot passengers. The *Appian way*, so much celebrated by Horace, was originally carried only to Capua, but was afterwards carried to Brundusium by Julius Cæsar, being altogether about 300 British miles in length: it formed one of the most splendid memorials of that emperor's reign, under which about two-thirds of it were executed. This famous road is in many places still quite entire, though understood to have seen its nineteenth century.

In Britain, the remains of the Roman ways are now hardly to be traced. They were generally termed streets, as Watling Street, Theneild Street, Erminage Street, and others. At *Castrum*, or Chester, one of the greatest Roman depots in Britain, some of the old roads are still to be seen, and occasionally compactly built pavements are discovered, with several feet of soil upon them. Roman roads have also been found in different parts of Scotland. A portion of one may still be seen leading from Musselburgh bay to Abercorn, one of their principal stations on the Frith of Forth. A portion of this street, termed the "Fishwives causeway" leads through the fields from Piershill Barracks towards Portobello. It consists of boulder stones very different in size, and is said closely to resemble some of the old Roman ways still seen in Italy.

The pontiffs and heads of the different Italian states succeeded the munificent reigns of the emperors in the government of this ancient kingdom, and following the established taste of that country for roads, Italy still preserves her celebrity for interior communications. Amidst the misery which the sway of Buonaparte entailed upon the countries on both sides of the Alps, it was fortunate that his measures ultimately tended to facilitate the intercourse between the ancient mistress of the world and the rest of Europe, by the improvement of the great passages across this mountain range, which was effected by the French and the Italians in the years 1804-5. Under the auspices of this great man, the Aurelian road has been thus adapted to the speed of the modern traveller. The track by the Simplon being generally at the rate of one perpendicular to twenty-eight horizontal, the postillion now takes that road, formerly almost impracticable, without requiring to slacken his pace. Among the difficulties to be encountered in the formation of this magnificent undertaking, there are several under-ground tunnels, the longest of which measures about 200 yards. It is curious thus to see the aggregate power of armies under the control of one individual directed to such objects. It is indeed doubtful whether at this moment the fame of the Roman emperors stands higher as conquerors, or for the works of art which they achieved; and we hesitate not to say, that the French Emperor's chief claim to true greatness will be sought for in the works which were executed under his powerful command as a *military engineer*.

Roads and Highways.

The French highways seem to have been modelled upon those of Italy, the great and early prototype of the nations toward the north. The roads which radiate from Paris, like those of Rome, are chiefly chaussées, *causeys*, or causeways. These consist of a bottom or foundation, carefully prepared, and previously drained, on which stones measuring about six, eight, and ten inches square, are set or built, the downward side being in the usual manner somewhat smaller than the upper one. The rock from which these stones are taken is generally quartzy sandstone, of considerable tenacity. The lines of direction of the French roads are for the most part straight, without much regard being paid on many occasions for more easy or favourable lines of draught. They are of a spacious breadth, varying from thirty to sixty feet, even seventy feet; the causewayed part is usually situate in the middle, being about sixteen or eighteen feet in breadth, with a bridle or summer road on each side. Many of the roads of France, however, like those of England, are made with metal or broken stones, a system practised even before the Revolution by the Etats de Languedoc, under the direction of M. Turgot in Limousin, &c. which now rather seems to be gaining ground, as forming a road so much smoother, and more agreeable than the irksome noise of the paved road. The chaussée in the middle being somewhat elevated in position, seems entirely to have precluded the idea of a footpath on either side; a comfort which rarely extends beyond the boulevards of the large towns. Nothing indeed surprises an English traveller more than to find Paris, the mistress of politeness, and the admired theatre of the arts, still without this accommodation excepting in a few streets at the Court-end of the town, where a kirb-stone is introduced, lining a somewhat elevated, though roughly causewayed footpath. In all other parts of that otherwise elegant city, the unfortunate pedestrian is left to trudge along under all the indignities of the bespattering *cheval* and his harassing driver, in their traverse course through the kennel in the middle of the street.

Roads of France.

The want of cross or parish roads is not peculiar to France; for there seems every where on the continent an almost total oversight with regard to their importance to the best interests of a country. They do not seem yet to have caught the English sentiment, so happily expressed by the late Dr. Anderson in his Rural Recreations. "Around every market place you may suppose a number of concentric circles drawn, within each of which certain articles became marketable, which were not so before, and thus become the sources of wealth and prosperity to many individuals. Diminish the expense of carriage but one farthing, and you widen the circle; you form as it were, a new creation, not only of stones and earth, and trees, and plants, but men also; and what is more, of industry and happiness." In France, notwithstanding the excellency of many of the principal roads, and the science displayed

Parish or cross roads.

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in their construction, the utmost difficulty is experienced in crossing that fine country. In attempting this, you at once get into a range of narrow lanes, beset with luxuriant furze and wild shades, forming no doubt an agreeable shade, but proving, upon the whole, a great annoyance to the traveller as well as to the husbandman. The present state of the continental parish roads forms a complete bar to the numerous advantages which would follow the establishment of some systematic mode of appointing trustees or commissioners from among the country gentlemen, who would then feel a more immediate interest in the internal improvement of their respective neighbourhoods. Such a system would excite a spirit of enterprise, carrying in its train numerous enclosures, drainage, and many local advantages, which in the present close and impracticable state of the country, can neither be foreseen nor undertaken.

We cannot withhold our admiration, however, of the facilities of the traveller on the roads of France. Take away the apparently useless and harassing system of passports, (at least during periods of profound peace,) and upon the French roads you proceed from the one end of the kingdom to the other without annoyance, or the occurrence of a single toll-bar. The same thing takes place with the mariner, who having cleared at one port, may put into any harbour, and enjoy the benefits of all the lights upon the coast without farther trouble; the whole community being considered as one great family; and the establishment for the erection and maintenance of roads, bridges, harbours, and light-houses being under one special board of engineers. This proves also an excellent system for training young gentlemen of talent, who having been placed at the polytechnic school in Paris, are, according to their several propensities and tastes, brought forward as civil and military engineers in all the departments of the French service. The school for civil engineers at Paris is somewhat analogous to our military college at Woolwich; by this means the country is supplied with an organised body of engineers, whose science and conjoined practice insure the systematic performance of all their public works. We cannot help expressing a wish that Britain and France, with regard to this department, were in some measure blended together; that in the road department for example, the French had, in connexion with their professional system, the aid, patrimonial interest, and local knowledge of the country gentlemen.

Of Spain and Portugal.

The roads of Spain and Portugal are generally allowed by travellers to be in a very indifferent state, and devoid of all the more recent improvements. Their direction proceeds with very little regard to the line of draught. Their surface is rough, and their repair but little attended to. The political situation of these countries for the last twenty years has been highly inimical to improvements of this description. They are every where nearer to the sea-coast than France, and have, upon the whole, less dependence upon the state of their roads for the transportation of troops. It has indeed fallen to the lot of few countries during periods of war, to proceed in the advancement of interior communication.

Germany and Prussia, &c.

The chaussée, or paved road, similar to that of France, is common in the most populous districts of the German and Prussian dominions; but over a great part of these countries, the roads are little more than formed, being almost without any prepared surface. Hence they are all run into deep tracks, which are extremely inconvenient to travellers; and therefore it becomes necessary, in the different circles or cantons to have different lengths of axles, so that a carriage properly fitted for a journey in Germany, requires that the wheels should be made to shift out and in at pleasure, to suit the tracks of different districts. The improvement of the roads has been undertaken in various parts of these countries; but it must be a work of much time before this can take place very generally.

Roads and Highways.

Holland and the Netherlands.

In Holland the traveller generally betakes himself to the numerous water-ways or canals of the country; but here time and patience are both necessary; for though the canals are spacious, the passage boats move slowly, and to suit a few trifling bridges by the way, (for they never pass through the towns,) are made so narrow that there is no more than sitting room in their cabins: the traveller's walk through the town, however, accompanying his luggage in a good day, under these circumstances, becomes rather a relaxation. The roads in Holland are generally carried in undeviating straight lines along that low flat country, between a double row of trees, with a great ditch on each side. Upon the tops of the national dykes, which defend the land from the inroads of the sea, the traveller is often upon pretty elevated ground, where his track takes many tortuous directions. The Dutch are at great pains in preparing as firm a foundation for their roads, as the nature of the country will admit. They are then built with thin bricks called *clinkers*, which are laid in lime, their longest direction being across the road; so that a carriage passes along in the same easy manner as if it were upon a railway. The people of Holland are generally reputed to be very slow in their motions; but their land journies are certainly exceptions to this; for in going to market, and even in farming operations, their carts are generally at speed. In the lower parts of the Netherlands, the roads partake a good deal of the Dutch construction, and in the higher parts, the chaussée occurs, which in some districts is laid with the greatest precision, and makes most excellent roads.

Sweden and Russia.

The Swedes have long had the character of being excellent road engineers. Good rock is very generally met with in Sweden; and they spare no pains in breaking it small. Their roads are spacious and smooth; and travelling in all their principal lines, is as easy as on the best roads of England. Where the country has been opened in Russia, the roads are formed on scientific principles; but they bear no comparison to the extent of that vast empire. Hence the unwieldy form of such a country, and the application of the Abbé Raynal's remark, "Let us travel over all the countries of the earth, and wherever we shall find no facility of trading from a city to a town, and from a village to a hamlet, we may pronounce the people to be barbarous; and we shall only be deceived respecting the degree of barbarism."

America.

Roads connected with Mexico and Peru have long existed; and among the other peculiarities of these states, the description of the excellent condition of some of their ancient roads has excited the surprise of Europeans. But the advanced state of this department, like many other earlier accounts of the New World, has been greatly exaggerated. More recent travellers have not been able to discover Montaigne's famous road from Quito to Cursoe, said to have been 300 leagues in length, and 25 paces in breadth, constructed with immensely large stones, with a running stream, and a row of trees upon each side.

In the cultivated parts of North America, the roads have latterly been much improved; and some of the principal lines are similar to the generality of English roads,

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which in construction they resemble. Along some of the morasses and inland parts of the country roads of some extent are actually made with logs of timber disposed as railways. For bridges, particularly of timber and catenarian arches with chains, the Americans have a considerable name, and have lately executed works of this kind of great extent.

In thus briefly noticing the roads of various countries, the object has not been so much with the expectation of instructing, as with the view of pressing a subject, upon the notice of travellers, which more or less concerns every one, that they may be induced to take notes in the course of their journeys in foreign countries upon a topic, regarding which conversational remarks are so common, though few of them reach the public in a precise and tangible form.

British roads.

In giving an account of the state of British roads and highways, we may take some retrospect of their advancement to a system. The sites of our ancient towns and cities were, for obvious reasons, chosen upon the wooded banks of rivers, where a supply of water and of fuel were conveniently within the reach of the inhabitants, and no doubt, at the period of their foundation, apparently in great abundance. Though the lapse of time may have been sufficient to clear away the forest, and the river or lake may now fall short of the increased wants of their surrounding population; yet in every instance, the evidence of the early existence of these may be traced in the immediate vicinity of all towns and populous districts. The change of circumstances produced by the gradual removal of fuel and building materials from the early settlers is very striking, and has of course given rise to the extension and improvement of interior communication. At a remote period, when each family formed a kind of community within itself for providing the necessaries of life, it is obvious that there could then be little communication with distant parts of the country, and there was therefore no use for roads, which long after the establishment of towns, must have continued in the state of footpaths and horse-tracks. The bulky articles of fuel and building materials are likely to have given the first idea of a sledge, the precursor of the wheel-carriage, and to have led ultimately to the construction of something like a road. As before noticed, our first roads were the military ways of the Romans; and even after the experience of ages, this department cannot by any means be said to be complete in all its details.

England.

The early roads of all new countries are therefore generally directed to the elevated grounds, with a view to avoid the marshes of the valleys, answering very well for bridle-tracks, but extremely inconvenient as carriage-ways: hence, as the habits of a country change, and the lower grounds are drained, the roads progressively get upon lower levels, and as they approach large towns and capital cities, become more spacious, and are made to diverge in all directions. As wealth and establishments are necessarily the precursors of improvements, we are naturally led to look to England for the earliest advancement in the road department. In the year 1285, we find the first law respecting roads and highways, by which it is enacted, that the proprietors of the land shall enlarge and "breadthen the ways where bushes, woods, and ditches be," to prevent robberies, and a train of evils to which the lieges in those days were thereby subject. In 1346 it was enacted, that Edward III. should be enabled to levy a toll on carts and carriages passing from St. Giles' in the Fields to Temple Bar; and also by the road which is now Gray's Inn Lane, both of which had then become impassable. But the famous act of Henry VIII. was the first measure of a general nature upon which all the after-improvements and extension of the road system were founded. By this act, the respective parishes were intrusted with the care of the roads, and surveyors appointed to be annually elected to take charge of them. It soon, however, appeared, that the funds allotted for this purpose were insufficient, and as the traffic of the country extended, the roads became hardly passable, while the several trusts were in a state of bankruptcy. The next measure was therefore to make them all turnpike, and toll-bars were accordingly set up, and those in future who used the roads, were made to contribute directly towards their support, a system which, under various modifications, has hitherto been persevered in. Now the whole face of the country is laid open with carriage ways, placed under various trusts or commissions, and although they have become very general, yet entirely new lines are occasionally formed, besides a constant improvement in the line of draught of the old lines, so that it may truly be said of road-making that it has no end. In England, the agriculture of the country got into a formed and improved state long before wheel-carriages came into general use; and, in this way, the practice of going over the hill is still too often persevered in, when a level, frequently as short, would be obtained by going round its base.

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There are many of the great lines of road which, to suit the facilities of modern travelling, still require a general improvement. The union with Ireland gave rise to the extension and improvement of the roads leading to the great ferries at Portpatrick, Holyhead, and Milford, which have severally undergone the latest amendments, especially the Holyhead line of road, passing through North Wales, by Shrewsbury and also by Chester, to London. Connected with these lines, a great bridge of suspension is now (1824) in progress at the straits of Menai, consisting of a catenarian arch of chains extending to 560 feet, between stupendous abutments of masonry; a work which is no less creditable to the British name than to the enterprise of the eminent engineer, Mr. Telford, under whose direction it is executing.

In South Wales a similar policy on the part of the government, will, no doubt, also fall in due time to be acted upon. The ferry between Waterford and Milford-haven, having now got steam-packets, may be made equally efficient with those of Portpatrick and Donaghadee, as it wants only the improvement of the roads through South Wales to complete that communication, which is somewhat shorter than the others to London.

Ireland.

In Ireland, the department of the roads is under the same description of management, by numerous trusts and commissions, as in England. In the beginning of the nineteeth century, the roads of Ireland were, generally speaking, considered in a better condition than those of any other part of the United Kingdom. Here the cross roads are also numerous, and in a tolerable good state of repair. The principal roads are spacious, varying in breadth from thirty to sixty feet, while the ditches and side drains are in many instances kept within the fences, and as the road-metal, consisting of lime-stone, and a kind of lime-stone gravel, is of good quality, the surface of the Irish roads is in general smooth and hard.

Scotland.

The road-system in Scotland differs considerably in the management from those of England and Ireland. The Scots local trusts are divided into districts, each of

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which seem to have a more independent control without reference to quarter sessions, as is the case in the other parts of the kingdom. In taking any general view of the roads of Scotland, they may be classed under three distinct heads: First, those of the southern counties, which have been wholly made and maintained by the statute labour and the rates collected at the toll-bars: Secondly, the military roads of the Highlands, made by the troops on the peace establishment, wholly at the expence of the public; and, thirdly, the roads made under the direction of parliamentary commissioners, at the joint expence of the public and the landed interest of the northern counties.

Military and Highland roads.

It is to the formation of the two latter classes of these roads that we perhaps owe much of our present taste for road-making throughout the united kingdom. The military roads had their origin in the rebellion of 1715, when it was found that the royal troops could not penetrate farther into the Highlands than Blair in Athol from the total want of roads. "The inhabitants of the Highlands," says Colonel Robert Anstruther's Memorial, included in the Parliamentary Reports, "a hardy race, accustomed from their infancy to arms, devoted to their chiefs, strangers to industry, and secluded from all intercourse with the rest of mankind, as well from their natural situation, as by their dress and language, formed a distinct people from the rest of the empire; and for ages, the government, the country, and the Highlanders, suffered greatly from these distinctions."

About the year 1732, General Wade was appointed, with the several regiments under his command in this district, to make certain roads, which should in future be sufficient for the conveyance of troops and military stores. The first line of road which they formed was from Stirling, across the Grampians, to Inverness, and from thence along the chain of forts, including Fort George, Fort Augustus, and Fort William, between the east and west seas, by which troops and artillery were carried with facility into the central Highlands, and thereby the disturbances of 1745 were speedily suppressed. By the year 1785, the military roads, including what has been termed the Galloway road, from Portpatrick to the river Sark, on the confines of Cumberland, extended to no fewer than about 788 miles, including 1011 bridges; and the light-house of Port Patrick. The improvement of the northern districts of Scotland became a still farther object with government about the year 1803, when a select committee of the House of Commons, among other objects, took under its consideration the farther extension of roads in the Highlands and Islands. Commissioners were appointed by Parliament with power to defray one half of the estimated expence, provided the proprietors of the land advanced the remainder. In this manner, by the year 1814, about 700 miles of road had been made under this commission. At this period, the whole of the military and more recent parliamentary roads of the north, now extending to about 1200 miles, were thrown into one general trust, with power to assess the counties to a certain extent, the government making up the balance of about L.10,000 per annum, as the estimated expence of their maintenance, including ferry piers, landing slips, inspection, and management.

Committee of House of Commons on Roads, &c.

In the history of the road department of Great Britain, one of the most important features of its progress was, the appointment of the committee on the roads and highways of England and Wales in the year 1806. The reports of this committee upon wheel carriages, and the construction of roads in general, are perhaps of the highest importance to our domestic policy ever made to Parliament. These reports contain a mass of information collected from men of the first consideration for scientific and practical knowledge; among whom we notice the names of Jessop, Walker, Cumming, Edgeworth, Ward, Boswell, &c. &c. It is, however, much to be wished, that the important labours of this committee had not terminated till they had proved, by actual experiment, upon the great scale, many of the scientific and elegant theories submitted to its consideration. By such researches, our improvement in roads, and in a more perfect construction of wheel carriages, would have been systematically continued, till we should have realized the ultimate benefits anticipated by the conclusion of the committee; namely, that no less than FIVE MILLIONS sterling might annually be saved to the public by following out the improvement of our road system, under the direction of parliamentary commissioners specially appointed for the highways of the kingdom.

Roads and Highways.

ROAD-MAKING.

From the historical sketch we have given of roads generally, it appears surprising how slowly such improvements advance to anything like perfection in the art. In illustration of this, we may take an example from the military roads above alluded to. Agreeably to the practice even late in the eighteenth century, roads were, in most instances, carried in a direct line, without much regard to the undulating surface of the country. The approaches to some of the most noted passes of the Highlands were so precipitous and difficult as to have been familiarly termed, "Rest and be thankful," "The Devil's Staircase," and the like, where stone seats were actually provided for the use of the hardy pedestrian. At one of these, a celebrated author having inquired at his guide what could have induced the gentlemen who commanded the troops on the service of the military roads to put their designations upon certain tablets set up by the way, he facetiously replied, "I know not, unless it were to afford the weary traveller an opportunity of *cursing* them by name and surname."

Line of direction.

Although in Road-making the Line of direction must always be subordinate to the Line of draught, yet the former is notwithstanding of importance, both as it regards the safety of the traveller, and the trackage of the load. Independently of the numerous accidents which occur, from the sudden collision of carriages travelling at speed upon a tortuous line of road, it were even better to go up a moderate acclivity, than to introduce numerous turns, which, to a certain extent, are not less detrimental to the effective power of the horse, than the up-hill draught. Every turn in the road, which ultimately amounts to a right angle, does in effect, suppose the carriage to have been brought from a state of motion to a state of rest, and from rest to motion again. Turns, in a road where they are unavoidable, ought to be formed on curves of as large a radius as the situation will admit.

In forming or laying out an approach to a mansion-house, we consult our taste, and are neither deterred by the elongation, nor winding direction of the road, in

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bringing the various objects of an interesting nature into view. In public roads however, this should very rarely enter into the design of the engineer, though other considerations, such as a more easy line of draught, a more suitable tract of ground, or the vicinity of good materials, will sometimes properly induce the adoption of a less direct course. The Roman roads were chiefly laid out in long straight lines, and the engineers of France, and other continental countries, have followed their example more closely than those of Britain. Extensive straight lines are doubtless irksome to the eye, and do not suit the associations connected with the ever-varying "line of beauty." But upon the king's highway, something is undoubtedly due to the ease of the horse. There ought, therefore, in laying out a road, to be a kind of compensating balance between the lines of direction and draught; and wherever weighty reasons occur for varying the direct line, such as an acclivity to be avoided, more proper soil to be obtained, the avoiding of valuable property, or the including of a village or town; where such motives present themselves, the judgment of the engineer will of course be exercised in varying the line of direction.

Line of draught.

One of the most important considerations in practice is the adoption of a proper Line of draught, according to the changing circumstances of the country through which the road passes. Wherever a level line of road can be obtained, it should in our opinion be adopted, regard being had to the drainage of the soil, and the particular form or curve given to the surface of the road. In how very many instances does the scientific engineer, when called on to improve a line of road, carry us along a uniform and easy acclivity, instead of an *intermitting track*, consisting of precipitous heights or abrupt hollows. If, for example, we take the difficult pass of "Rest and be thankful," in Argyleshire, where the road is carried through the pass of Glencrow, along an undulating line of draught, it might, upon leaving Loch Long, be made to rise upon a very gentle and uniform acclivity all the way, admitting, however, of occasional level parts for the relief of the draught. In like manner, on the Loch Fyne side, a much more easy line of draught than the present might be found to the same summit. Similar instances everywhere occur, in travelling over the chalk, lime, and sandstone knolls of the south; one or two of these may also be noticed. On the great north road, perhaps the worst stage between London and Inverness is that between Newcastle and Durham, and here the error might in a great measure be avoided, by merely varying the line of direction. Another instance is upon the great road from London to Ireland, through South Wales by Milford. The stage alluded to is that between Bristol and New-Passage ferry, which is extremely tortuous, both in its line of direction and draught; although, by keeping along the right bank of the Avon, the road might be shortened, and preserved nearly upon one level.

Opinions about this.

We must not, however, omit to notice that various opinions exist with regard to the most proper line of draught; some think that an undulating line is better than one which is level. As this idea seems to strike at the root of all our road improvements, it will be proper to bestow more attention upon it, than it would otherwise from its obvious nature seem to deserve. It is contended by many, that horses are more fatigued with their load upon a level road, than upon one which goes up and down hill. This view is generally supported by arguments supposed to be derived from the anatomical structure of the horse, and from the various muscles of the body being thus alternately brought into action. But we may notice, that in an up-hill draught, a carriage may be conceived as in the state of being continually lifted by increments proportional to its rise or progress upon the road, as already mentioned under the article RAILWAY. We may also show this practically, as every one knows that on a stage of twelve miles the post-boy generally *saves*, as it is termed, at least half an hour upon the level road, because on it he never requires to slacken his pace as in going up-hill. Now, if he, or his company, would agree to take the same time to the level road that they are obliged to do upon the undulating one, the post-master would find no difficulty in determining which side of the argument was in favour of his cattle. With regard to the fatigues or ease of the horse, the writer of this article not having such plain matter-of-fact for his guidance, upon one occasion submitted the subject to the consideration of a medical friend, (Dr. John Barclay, of Edinburgh, no less eminent for his knowledge, than successful as a teacher of the science of comparative anatomy,) when the Doctor made the following answer:

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Dr. Barclay's opinion.

"My acquaintance with the muscles by no means enables me to explain how a horse should be more fatigued by travelling on a road uniformly level, than by travelling over a like space upon one that crosses heights and hollows; but it is demonstrably a false idea, that muscles can alternately rest and come into motion in cases of this kind. The daily practice of ascending heights, it has been said, gives the animal wind, and enlarges his chest. It may also, with equal truth, be affirmed, that many horses lose their wind under this sort of training, and irrecoverably suffer from imprudent attempts to induce such a habit." In short, the Doctor ascribes "much to prejudice originating with the man, continually in quest of variety, rather than the horse, who, consulting only his own ease, seems quite unconscious of Hogarth's Line of Beauty."—*Report on the Edinburgh Railway.*

Formation and drainage.

Due regard having been paid to the lines of direction and draught, the road comes to be formed perhaps through an undulating tract of country, and over a variety of soil, requiring different modes to be specified for its execution. One ruling principle, which should pervade the whole system of the formation of roads, is their thorough drainage. The smaller drains, connected immediately with the road, must vary in their number, direction, and description, according to the judgment of the engineer. They consist of what are technically termed *box* and *rumbling* drains; the former of which are built, and the latter consist of a stratum of ruble stones, simply thrown into an excavation made for their reception, through which the moisture is allowed to percolate. Where the road is to be made through a boggy or marshy soil, which is generally pretty level, the opportunities for drainage are less obvious; nor is this so material, as ground of this description is capable of containing a great quantity of water, without endangering the flooding of the road. In such situations it also fortunately happens that land is seldom of much value, and therefore, in making a road through a morass, a much greater breadth should be included between the lateral drains than where the ground has an

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undulating surface. Attention should also be paid to cut the ditches of a moderate depth, as the tenacity of such soils depends upon their being kept in a somewhat moist state. If a section of such ground be exposed to the sun and air, by deep side cutting, it soon pulverizes, and loses its elasticity, when the level of the road falls, and its surface gets into disorder. The drainage of a road should rather be made across than in a lateral direction, as being less apt to be injured by the traffic upon it. Whatever degree of convexity is given to the cross section of the surface of the road, the same figure should be given to the bed or ground on which the broken stones are to be laid. By this means the drainage will be assisted, and the metal preserved of an equal depth throughout, instead of being thicker in the middle, or under the horse path, than where the carriage wheels travel. By this means also a considerable portion of metal will be saved, especially in situations where it is laid of the whole breadth between the side drains. This is further illustrated by Fig. 4, Plate CCCCLXXX. and its description at the end of this article.

The curve, or top line of the cross section of the road, is also important, and its degree of convexity should be regulated very much by the line of draught, the principal object being to carry off the moisture by surface drainage. But, for this purpose, the declivity from the centre to the sides may be very gentle, it being only wanted to take it off so easily as not to endanger the washing of the pulverized stuff entirely away or rutting the surface. To provide for the rain-water flowing in direct lines from the centre to the sides of the road, would be to *barrel* or round it too much, as was the case formerly, even to a degree that was dangerous for carriages. The cross-section of a level track of road should be elliptical, falling from the centre to the verges on either side, at a rate not exceeding an inch and a half perpendicular to a yard horizontal. But where an acclivity in the line of draught occurs, where carriages are in the greatest danger of being upset, the surface of the road should be kept flat, or with a fall not exceeding three quarters of an inch to the yard, to take the water gently off toward the sides, and prevent it, during heavy rains, from rutting the road in a lateral direction.

Breadth of the road.

It has been complained that many thousand acres of land throughout the kingdom are lost to the agriculturist, from the increased breadth which is now given to our public roads; but this, to say the least, is a very narrow view of legislative policy. Independently of the safety and conveniency of the traffic, the mere consideration of drying the road by more speedy evaporation is a sufficient reason for preserving a spacious breadth in the formation of all roads, while the effects of the rising growth of the hedge-rows, and the ultimate erection of buildings along it will be rendered less injurious. The highways or great lines of road should, in no instance, be formed of a less breadth than forty feet, and the metal bed not less than eighteen feet broad, with at least one footpath of five feet in breadth along the side; especially within a few miles of all towns and villages. It would be difficult to give any scale of breadths for public roads, the local circumstances of which vary so much. But, without presuming to be fastidious, we notice, that, within six or eight miles of all large cities or towns, the approaches should not be formed at less than sixty feet between the fences. In such situations the whole breadth should be metalled, or laid with broken stones. In the vicinity of towns of about 50,000 inhabitants, the breadth should be at least fifty feet between the fences, and be in like manner metalled from side to side. Where the population does not exceed 30,000, the statutory breadth of forty feet may be adopted, the metalling being still continued of the whole breadth, with paved side-drains. At intermediate distances, where it is not thought advisable to have the metal of a greater breadth than eighteen feet, the compartments between the metal bed and the side-drains may be laid with gravel or chips of stone to the depth of not less than half the thickness of the central part of the road. In the vicinity of London, and the capitals of Dublin and Edinburgh, and other great towns, as Glasgow, Manchester, Liverpool, &c. it would be desirable that the principal approaches were at least seventy feet in breadth, fully metalled between the side-drains, which ought to be neatly formed, and paved, and the roads provided with a foot-path on each side.

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Fabric of the road.

By the fabric of the road is more particularly meant the component parts of the metal bed. Where the bottom is naturally wet and spongy, it is well to *ram* it with chips of stone or with rubbish somewhat freed from earthy particles. It is extremely desirable, in every situation, that the road-metal should be broken to a uniform size, so as to form a compact body throughout. But, as the preparation of the small metal suitable for the surface of a road is expensive, it will, in many situations be found advisable to lay a stratum or course of *hand-laid* stones, of from five to seven inches in depth, with their broadest ends placed downwards, and the whole built compactly together, upon the prepared bed or soil. On this course of stones, broken metal to the depth of not less than eight inches may be laid, though the quality of the rock should be kept in view in fixing the depth of this upper stratum. In fixing upon the size of the top metal, the more hard and tough its nature is, the smaller it may be broken; it being an object of main importance to have the metal "well assembled," as the road-makers express it, or broken of a uniform size. In almost every county there is a variation in the quality of the rock, and also in the size to which it is broken. Roads have latterly been made under a specification as to the weight of the pieces, varying from six to eight ounces. Formerly it was not uncommon to have them specified, of the size of a "hen's egg," or even of "a man's fist." By reference to weight, the road-maker's operations became more precise; but regard should also be had to the specific gravity of the materials, which differs considerably. For example, granite may be taken at twelve cubic feet in the ton, and whinstone (the greenstone, basalt, and clinkstone of mineralogists) is often met with of similar weight. Compact limestone and flint are about fourteen, and quartzy sandstone about fifteen feet to the ton. Perhaps the most convenient and uniform test for the size of road-metal is a ring measuring two inches and a half diameter in the void. When the metal is thus broken, and the road carefully treated, its surface soon becomes smooth and compact, without requiring the addition of blinding, or filling up the interstices with gravel, which, if used, should be free of earthy particles. But this addition is hardly necessary, where there is much traffic, as the rough and angular sides of the metal soon lock into each other, and form a smooth surface.

After opening a new road, a weighty roller may be

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passed over it with advantage; but attention should be paid to working the whole surface equally, and raking the displaced stones into the tracks, to prevent these from becoming deep ruts. For this purpose, wooden tresses are now generally set across the metalled part of the road; and, by shifting these, the carriages are made to pass alternately over the whole surface, and obliged to take up new tracks, until the whole becomes smooth and compact. Such treatment, in the first instance, effectually prevents it from getting into disorder; and to this simple operation we are very much indebted for the improved smoothness of our roads. With regard to the theory often advanced, by which the bottom or hand-laid stones are said to work their way from the bottom to the surface, and to be thus supplanted by the top metal; we cannot help thinking that much of this appears to be fancy; and that this has been generally owing to the more careless manner in which new roads were formerly constructed, and also to the little care which was afterwards paid to them. It is, in fact, quite notorious, that, till within a short period, there was, throughout the kingdom, a very general want of systematic attention, both in the making and upholding of public roads. The metal was neither uniformly broken nor judiciously applied; nor was the fair and regular working of the road duly attended to. Our new roads, consequently, got into ruts soon after they were opened to the public, by the displacement of the broken stones before they became bonded or connected with one another; and it generally happened, that the appearance of the bottom metal was the first intimation of the top-metal having been worn out, and the road in a state of total disrepair.

Gravel roads.

The chaussée, or paved road, is so universal on the continent, and the proper gravel road so common to the southern districts of England, that foreigners, from the smoothness of the British roads, give the general appellation of gravel roads, even to those that are made with small broken stones. The use of small gravel from the sea beach upon public roads, can hardly be considered suitable, as they seldom bind or form a compact road like broken metal which has a number of rough sides and angular points to connect it. Gravel answers very well upon the side compartments, between the metal-bed and lateral drains, and also for foot-paths; but should not be used for the central parts, unless it be laid nine or ten inches in depth, and of a size which will barely pass through a ring of about one inch in diameter. If it be of a larger size it should be reduced by the hammer, and then it makes a most excellent road. In mountainous districts, a peculiar description of road-metal is sometimes found, which is technically termed *mountain-gravel*. It occurs along with minute portions of earthy or clayey particles, which have the property of binding the whole together, and makes an excellent smooth road for light carriages.

Distribution of road-metal.

In the selection of road metal, we should always give a preference to the several varieties of greenstone. The best kinds of these are less friable than granite, when broken into small pieces. There is, however, no rule without exceptions, and it is often necessary, for want of better materials, to use sandstone, common limestone, and chalk, even in districts where there is a great deal of traffic; in some instances where coal is abundant, sandstone is reduced to a vitreous mass in kilns erected by the road side; but all such road metal is now used very sparingly in the formation of modern roads, and confined chiefly to the bridle-tracks. The distribution of road-metal may be considered as partial and irregular. Throughout Scotland, and even as far south as the approaching sources of the rivers Tees and Ribble, good road-metal is generally to be met with, containing the numerous varieties of granite, greenstone, basalt, porphyry, and limestone. South of this boundary, as far as the Trent and the Dee, in Cheshire, the formation is chiefly coal, sandstone, and the softer varieties of limestone. In the southern counties chalk and gravel soils chiefly occur, affording flint and gravel, both of which, under proper management, make excellent roads. In North and South Wales, we have all the varieties of road-metal which are common to Scotland. In Ireland they have excellent road materials, as granite and limestone are pretty generally distributed.

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Difficulty of preserving smooth roads.

Notwithstanding the improved state of our roads, and that every pains is taken to obtain the best road-metal, yet it is impossible to preserve a smooth surface with broken metal, excepting at a great expence. It is quite astonishing in how short a period our best roads get into disrepair. Where there is much traffic, it requires constant unwearied attention to keep them in good order; and the waste of materials is almost incredible. Of this every one may satisfy himself, even from the quantity of clayey stuff which is occasionally raked off the roads in wet weather, or blown away in the state of dust in dry weather. Indeed, we hesitate not to express our fears that broken metal will be found unsuitable for the thoroughfares of great towns. We have observed where this has been tried, in some few instances, in England and South Wales, that the inhabitants complain of having "all the dust of summer, and all the dirt of winter."

Causeways.

From the difficulty and expence of keeping causeway-ed streets in a tolerably good state of repair, together with the jolting and jarring noise which attends them, the public has long been in quest of a smooth and durable city-road. Even cast-iron plates, in the form of causeway, have been tried. The small metal system is also in the act of being tried on several of the streets of London; but as yet experience does not enable us to say with what effect. In London, Dublin, Edinburgh, and other large towns, the streets are paved generally with granite or greenstone. This description of paving is properly of two kinds, the one termed ruble causeway, in which the stones receive a very partial chipping or hammer-dressing from the pavier. The other, termed aisler causeway, is more carefully dressed. The stones are also of a larger size, varying from five to seven inches in thickness, from eight to twelve inches in length, and about a foot in depth. The late introduction of this description of causeway, was considered at the time to be the perfection of this kind of road. But notwithstanding many precautions to the contrary, all dressed causeway stones are formed with the lower end, or that which is set on the ground, somewhat smaller than the upper surface. The consequence is, that they too often only touch at or near the top, and when a pressure comes upon one end of a stone so laid, it is apt to sink, while the other end is proportionally raised, and in this manner the causeway becomes dislocated, and gets into numerous hollows. This operation is still more rapid in the ruble causeway, which consists chiefly of small

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angular pieces of a variety of forms, which more easily give place to the pressure of a carriage-wheel than the boulder or rounded stones, of which the Romans made general use, and which are still applied to streets both in England and Ireland. These stones, having a broad seat or bed, are not easily misplaced, though they make a very rough, noisy, and unpleasant path.

Principal causeways.

Perhaps the finest specimens of the aisler causeway to be met with in the united kingdom, are those of the Commercial Road of London; Great Sackville Street, in Dublin, and Leith Walk of Edinburgh. The traffic upon the whole of these streets is great. The latter forms almost the only thoroughfare to the port of Edinburgh. It is regulated by a special Trust, and its toll is generally rented at about L.5000, per annum. The causeway of Leith Walk is nearly two miles in length, its breadth between the kirb-stones, which line off a spacious foot-path on each side, may be taken at the average breadth of fifty-seven feet. The stones of which it is paved are of a cubical form, of the largest dimensions of aisler causeway, laid upon a bed of sharp *sea-sand*, free of earthy particles, measuring twelve inches in depth. It is now fourteen or fifteen years since Leith Walk was converted, from a very bad common road, into a spacious causeway, and although its surface now exhibits many inequalities, yet it has continued during that comparatively long period, and may continue as long, without requiring any considerable repair. Now, if we compare this with the continual repair to which all metal roads, with a traffic similar to that of Leith Walk are incident, we presume that the metal would require to be renewed at least every third year. It must, therefore, have cost, upon the whole, a much greater expence than causeway, independently of the inconvenience which attends frequent operations of this kind upon such a thoroughfare; and its annoyance from dust, &c.

Wheel-tracks of stone.

If, therefore, we can suggest a system of road making which shall secure to us all the advantages of a smooth and uniform railway, with the ultimate economy of the aisler causeway, we conceive that much shall have been gained, towards the facility of carriage, and the comfort of travelling. This we propose to effect by laying stone tracks, if not throughout the whole extent of certain principal roads, at least upon all their acclivities. These undulations oblige the carrier to modify his load, perhaps to one-half of what he could take upon a level road. If, in the same manner, the streets of towns and villages situate on the highway were laid in this manner, the traveller would pass smoothly along at his ease, instead of the thundering noise and jolting motion so irksome to himself, and dangerous and annoying to the respective inhabitants. Nothing is more common than the expression, "Now we have got off the stones we shall be safe and comfortable." The writer of this article remarks, in proof of this, that, in the course of his numerous journeys, he has been thrice in a carriage broke down, and upon two of these occasions he was passing along a city road.

Use of large stones inconvenient.

We have already remarked that some of the Roman highways were formed with squared materials of large dimensions, as is still the case in Milan, and other cities of Italy. Several tracks of stone-rails of limited extent are to be met with in various parts of Britain; the stones of which these railways are composed, generally measure from three to four feet in length, from ten to twelve inches in breadth, and from eight to ten inches in depth. In the neighbourhood of Aberdeen there is a granite railway of this description, which runs several miles along, or in conjunction with, a common metalled road. But we observe that, unless stones of such lengths as three or four feet be deeply seated in the ground, and altogether contain as large a mass of rock as those of Italy, in proportion to the greater weight of English carriages, they will be too weak for their length, and it will hardly be possible to keep such rails firmly in their places, and in this way the chief benefit of a connected railway will be lost. Besides, large stones are always more difficult to be procured, transported, and laid in their places, than stones of smaller dimensions. An objection of no small importance also occurs in the use of these large materials, from the danger there is of horses slipping their feet and coming down upon the road. To avoid this, the practice in Italy is to keep the stones in a rough state, by occasionally cutting grooves upon the upper surface with a pick-axe, when they get into a smooth state with the carriage-wheels. This mode of paving with large blocks has in some instances been practised on a small scale in London, with granite; but in order to give stones of this kind the necessary stability, the blocks would require to be cubes, or to have their dimensions equally large on all their sides, which, upon the whole, would be attended with a great expence.

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Plan by Mr. Matthews.

It appears from the reports of the committee of the House of Commons, on the improvement of roads and highways, that Mr. Henry Matthews, of Walworth Common, proposed a plan for stone-railways upon an extensive scale, for the principal highways of the kingdom. The stones which he was to employ, were to measure about four feet in length, ten inches in depth, eleven inches in breadth at the top, and fourteen inches at the base. At the points of contact the stones of some of these tracts were to be connected with a smaller block, by a kind of mortice-formed joint, similar to those represented in Figs. 5, 6, and 7, Plate CCCCLXXX. and described at the end of this article. The expence of Mr. Matthews' plan was probably one of its chief objections, having been estimated at L.1, 5s. per lineal yard for each set of tracks. It would probably also have been found in practice, that unless the cubic contents of these blocks had borne a greater proportion to their length, they would not have withstood the necessary pressure of carriages.

PLATE CCCCLXXX. Figs. 5, 6, 7.

Plan by Mr. Stevenson.

In the several examples of this description of railway which we have met with, the stones have always been of considerable lengths. Now, it appears to us that, by introducing numerous joints, we shall not only secure the safety of the horses, and prevent the risk of their falling, without the trouble of cutting grooves in the stone, but that by keeping them of a length not exceeding that of the best aisler causeway, we shall, at a moderate expence, be able to procure materials proportionable in all their dimensions, and which can be easily kept in their places. This will be more readily understood when it is considered that a carriage-wheel impinges or rests only upon about an inch of its track at a time in the course of its revolution. There is, so to speak, a kind of compensating effect, connected with the use of small stones, which prevents the tremour from being communicated beyond the limited sphere of a few inches, instead of several feet.

In the *Transactions of the Highland Society of*

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Scotland, vol. vi. this mode of making a smooth and durable road, by laying tracks with stones not much larger in their cubic contents than those of aisler causeway, is described as equally applicable to the streets of a city and the acclivities of the highway. Indeed, judging from the duration of causewayed streets, such is the comparative economy of this system, that we despair not of seeing it very generally used on our public roads. It appears to have been first proposed for the main-street of the town of Linlithgow, which forms part of the great western road through Falkirk to Stirlingshire, by Mr. Stevenson, engineer. Specimens of these tracks have been submitted to the inspection of Lord Melville and to some of the leading road-trustees of the county of Edinburgh, and to several of the commissioners for paving the streets of the parishes of London, where it is expected to be submitted to trial. This plan will be readily understood by examining Figs. 1 and 2, Plate CCCCLXXX. and its letter-press description at the end of this article, in which a street or highway, supposed to measure about thirty feet in breadth, is laid out in five compartments, independently of the footpaths. Two of these are paved with the aisler causeway tracks, laid five feet apart, while the intermediate spaces for the horse-paths may either be of ruble causeway, or broken stones in the usual way.

PLATE CCCCLXXX. Figs. 1, 2.

Description of the tracks.

The tracks may be formed of granite, greenstone, or any of the hard varieties of rock which is capable of being dressed with a hammer, to dimensions not less than the following;—say, from six to eight inches in the length way of the track, twelve or fourteen inches in depth, eighteen inches in breadth at the base, and twelve inches at the top or wheel-track. The sides of the stones where they come in contact with each other, are to be dressed so as to form a plain close joint across the track, and the top is to be flat, that carriages may move without obstruction off and on the tracks, and, like the other sides, is to be dressed after the ordinary manner of aisler causeway. In laying these tracks, all that becomes necessary is to bestow some pains in preparing a firm and compact foundation, the nature of which will in a great measure depend upon the soil. A stratum of stone chips, of the depth of three or more inches, according to the state of the ground, laid in clean sharp sand, will answer in almost every case. It would, in some instances, be of advantage to lay the tracks with runners upon each side as kirb-stones, of about twelve or fourteen inches in length, especially in connexion with the common metalled road. But where ruble causeway is employed for the horse-paths, this precaution is unnecessary. In upholding roads of this description, the intermediate spaces will seldom require repair; and we have seen, in the example of Leith Walk, that aisler causeway has continued in good order for about fifteen years, and may last double that period with occasional repairs. Although the traffic of carriages would be greater upon the tracks than on a common road generally, yet it is a curious fact, that however spacious a road may be, carriages go very much in particular lines, one after another, and therefore the duration of an aisler causeway forms a very good criterion in judging of the comparative economy of the proposed wheel-tracks.

Smoothness and quietness of the road.

The smoothness of railway travelling has often been spoken of as luxurious, while the quietness with which vehicles glide along suit even the delicate ears of a Hollander, who, partly from this feeling, is induced to deprive the heavy loaded carriages and hackney coaches of their wheels, and form sledges, as is the practice in Amsterdam and other large towns of Holland. Till of late years, the thoroughfare into Somerset House, like the whole included area of that elegant suite of buildings, was paved with rough granite stones, and during the sittings of the Royal Society, and other public bodies, which held their meetings in the front row, the members were often disturbed by the noise of the carriages passing under the covered way into the square. This particularly attracted the notice of strangers, and the entrance alluded to has lately been laid with gravel, which, though not so cleanly as the tracks, is nevertheless a great improvement.

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Expence of stone-tracks.

On the score of economy, we may notice that in the vicinity of Edinburgh, where good road materials of every description may be had at moderate rates, a lineal yard of these tracks, forming a road for one carriage, will cost from seven to nine shillings, according to the weight of the load to be conveyed upon them; and consequently double of these sums for two sets of tracks, to suit carriages travelling in opposite directions. These tracks may be estimated to last about twelve or fifteen years, in the ordinary traffic of a city or public road, in the course of which the metalling of a common road must have required to have been frequently renewed. Not only, therefore, will the comfort of the traveller be provided for, and the wear and tear of his carriage prevented, but the direct economy in upholding the public roads will, by the adoption of this system, be secured to an immense extent. An idea of this may be formed from the Reports of the Committee of the House of Commons, which goes the length of stating, that even FIVE MILLIONS Sterling annually may be saved to the public by an improved system of roads.

Iron wheel-tracks.

Iron railways of the form hitherto in common use have of late been suggested both for travelling at speed and in the conveyance of all sorts of goods. Mr. Menteath of Closeburn, a considerable time since, made some progress in showing the application of iron wheel-tracks upon the numerous declivities which are every where met with upon the common road. This idea has also been acted upon by Mr. Baird of the Shotts Iron-works, which are situated on the side of a dell, in the bottom of which his foundery is built. In order to give greater facility in bringing up weighty articles from the works, Mr. Baird laid a very complete set of cast-iron tracks, applicable to the traffic of common carts, which admitted of the same load up-hill as in ordinary cases could be drawn upon a level road; a model of these tracks has been lodged in the chambers of the Highland Society of Scotland; they measure one foot in breadth, an inch and a half in thickness, and are fixed into the check of a cast-iron sleeper or bed, laid across the road in such a manner that they are neither apt to slip aside, to rise perpendicularly, nor to be sunk below their proper level; being nearly flat at the top, they admit of the wheels of a carriage getting off and on them at pleasure. The expence per lineal yard is understood to be about L.1, 5s. A rail-road of this kind was, in the year 1816, laid for the Forth and Clyde Canal Company, upon an acclivity leading to Port Dundas, near Glasgow, at the rate of

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one perpendicular to about 15 horizontal. In the presence of a committee of the Canal Company, one horse actually took up a load of three tons upon a common cart weighing nine cwt. without any apparent difficulty, till he reached the top of the railway, and was about to enter upon the common causeway. But, although the causeway was in good order, and the line of draught had become easy, the animal could proceed no farther than the extent of the cast-iron tracks. In any view of the application of these tracks to the partial acclivities of the common road, it is important to mention that the carters frequenting Port Dundas all agree in stating, that their horses had formerly as much difficulty in taking up 24 cwt. on the common causeway, as is now experienced with a load of three tons upon these wheel-tracks. Let us therefore consider the beneficial effects of such an immense acquisition of power, as the use of wheel-tracks would prove to carriage upon the great scale!

Road engineers.

In an article treating distinctly of roads, we trust it will not be considered out of place if we notice two or three professional gentlemen who have more or less directed their attention to the road department of the engineer, and it is rather curious to notice that these happen to have belonged to Scotland. It was, we believe, the late Mr. Charles Abercromby who first adopted, as the leading principle of his designs, a more improved line of draught than the example either of the military or civil engineers of a more early period had afforded. But the appointment of Mr. Thomas Telford, as engineer to the Parliamentary Commissioners for roads and bridges, and the field thereby opened for his practice, may doubtless be mentioned as one of the most fortunate circumstances in the history of our improvement in this art. The highest praise is due to that eminent individual for the magnificence and extent of his various designs; and especially for the sedulous attention with which he has directed his great talents to all the details of Road-making. To these we gladly embrace the opportunity of adding the name of Mr. Loudon MacAdam, eminent as the founder of a system by which our public roads, formerly strong, though rough, are now becoming generally smooth, firm, and compact.

System of management.

The country is perhaps not more indebted to the labours of the engineer than to the regular system of management which the road trustees have latterly adopted, both in respect to the conduct of their works and the management of their funds. Though Britain has not an organised professional board like that of France, for roads, bridges, harbours, and sea-lights, in one connected body, yet, in the affairs of roads, she may be said to possess a universal *Board of Freeholders* and their eldest sons, who, as trustees, manage those concerns with a patriotic feeling, a patrimonial interest, and a local knowledge, which has brought the British roads to their present state of pre-eminence. From time to time these gentlemen call professional men to their assistance, without sparing their own trouble, or withholding security, often to a great extent, upon their lands, for carrying on the operations of the trusts of which they respectively take the responsibility.

The management of roads is now so systematized as to have become, upon the whole, extremely simple. In Scotland, and now also pretty generally in England, the statute labour is commuted into a payment in money instead of personal service. With this fund, and the dues collected at the different toll-bars, the highways, parish and cross-roads, are made and maintained. The benefits of system, even in point of economy, is such, that some of the districts pay at the rate of L.700 or L.800 a-year, to the superintending engineer, for the management of about 150 miles of road. The more general way, however, in Scotland is, for the convener of the district to employ a thorough bred practical road-maker, who, as Inspector, receives a modified salary, attends to the state of the work, and directs the upholding of repairs. The road-metal, agreeably to this system, is quarried, carted, and broken by contract, at so much per cubic yard of broken stone. It is then, according to what we conceive to be the best arrangement, laid upon the road by day's wagemen. The money disbursements are made by the treasurer for the district, upon statements of the work done. In this manner the check on all hands is simple and direct, and there is not now the same opportunity for peculation and oppression that existed while the statute-labour was personally exacted.

Roads and Highways.

In all improvements of any extent the trustees now proceed in a regular manner by plan, specification, and contract, instead of the more loose mode that was formerly practised. We have indeed been called to take a road off the hands of contractors, whose work amounted to several thousand pounds. The operations consisted in making the road partly new by certain alterations in the line of direction, while the remainder had undergone a thorough repair. In calling for documents it appeared that the line had never been professionally surveyed, that no section of the earth-work, or blasting of rock, had ever been made, nor had any regular contract been entered into. The works were inspected by the factor on a neighbouring estate, and afterwards travelled upon for twelve or fifteen months, without any precaution in filling up the ruts. This procedure arose from a misconceived and ill-applied economy; which has too often led business of this kind to be settled in a court of law, as in the instance alluded to.

Description of Plate CCCCLXXX.

Description of PLATE CCCCLXXX. Fig. 1.

Fig. 1. represents the plan of a street or road laid with two sets of stone-tracks formed of what may be called aisler, or the best description of causeway, of a form peculiarly simple, of dimensions easily procured, and calculated for supporting any load. Between, and on each side of the tracks of this diagram, the compartments are formed of common road-metal. The track-stones may be of granite, greenstone, or any of the harder kinds of rock that will admit of being *hammer-dressed*. To be properly bedded or laid upon a stratum of clean sharp sand, gravel, or stone chips, according to the state of the ground, and the situation of the country for procuring materials. At Bath, Paris, and other places, we have seen causeways carefully built with lime-mortar.

Referring to Mr. Stevenson's plan.

A B C D point out a compartment of a road laid partly with broken stones, in which E E and F F are the aisler-causeway tracks, A B being the sky or open drain upon the side of the road, which, if situated within, or near a populous town, is supposed to be

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